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MEMORANDUM FOR PRS (Contractor/In-House Publication)

FROM: PROI (TI) (STINFO)

25 Aug 2000

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-AB-2000-169**
G. Scriven, N. Gat (OKSI), R. Lyons (ERC), "Monocular Passive Ranging Sensitivity Analysis and Error Minimization" (Abstract)

2001 Meeting of MSS Specialty Group on MD-SEA
(Monterey, CA, 30 Jan - 01 Feb 01)

(Statement A)

(Submission Deadline: 25 Aug 00)

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PHILIP A. KESSEL Date
Technical Advisor
Propulsion Science and Advanced Concepts Division

Monocular Passive Ranging Sensitivity Analysis and Error Minimization

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Abstract

Monocular Passive Ranging (MPR) may allow accurate target range estimation even when active measurements or multiple views are not possible. Due to the inherent nature of the MPR solution, the uncertainties may degrade the utility of the range estimate. Proper spectral band selection is essential for error minimization. The study goes beyond the traditional CO₂ red spike band for MPR. Featured in the current analysis are the following absorption bands: O₂ at 0.76 microns, CO₂ at 2.0 and 4.3 microns, and Ozone at 4.7 and 9.6 microns. More importantly, a sensitivity analysis procedure is presented that both minimizes these errors and provides an uncertainty assessment of the range measurement. The result is an improved ranging capability and a more accurate characterization of the intervening atmosphere. The solution technique is applied to an actual HALO/IRIS measurement (Black Brant). However, the MPR software is designed to provide real-time range estimations and atmospheric compensation. A research version of the code has been developed to support integration of this technology into the HALO/IRIS upgrade.

Outline

1. Introduction
2. Solution Technique
 - 2.1 relevant physics
 - 2.2 spectral band selection
3. Sensitivity Analysis
 - 3.1 automatic differentiation (AD)
 - 3.2 identifying key input parameters
4. Error Minimization
 - 4.1 pre-flight onboard measurements(local atmosphere, star measurements, ground measurements)
 - 4.2 response surface (from AD)
 - 4.3 recursion analysis
 - 4.4 uncertainty estimation
5. Data Comparison
 - 5.1 Black Brant measurement from HALO/IRIS
 - 5.2 data vs. model range estimation
6. Integration into HALO/IRIS Upgrade
 - 6.1 HALO/IRIS instrumentation description and capabilities
 - 6.2 Software architecture (HALO/IRIS + MPR)
7. Recommendations
8. Summary

Comments

State-of-the-art Advancement:

Automatic Differentiation (AD) is an emerging technology that is currently under utilized in the field of remote sensing and related phenomena. AD can be applied to existing models for sensitivity analysis. It can also be integrated into the model development itself for improved robustness and more expedient programming.

Key results:

The utilization of multi-spectral sensors, combined with a pre-flight measurement process, extend the envelope of MPR applicability. Previous techniques have broken down for up-looking scenarios. The technique presented in this paper will provide improved ranging capabilities even for some up-looking view geometries.

An accurate MPR technique provides the target trajectory and atmospheric compensation. Both of these are needed for improved target typing, discrimination and tracking.